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1    *Title:* Factors Impacting Match Running Performances of Elite Soccer Players: Shedding Some  
2    Light on the Complexity

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## Abstract

Time-motion analysis is a valuable data collection technique used to quantify the match running performance of elite soccer players. However, interpreting the reductions in running performance in the second half or temporarily after the most intense period of games is highly complex, as it could be attributed to physical or mental fatigue, pacing strategies, contextual factors or a combination of mutually inclusive factors. Given that research in this domain typically uses a reductionist approach whereby match-running performance is examined in isolation without integrating other factors this ultimately leads to a one-dimensional insight into match performance. Subsequently, a cohesive review of influencing factors does not yet exist. The aim of this commentary is to provide a detailed insight into the complexity of match running performance and the most influential factors.

**Key words:** *fatigue, pacing, dynamics, tactics, context*

## Introduction

In the last decade there has been an exponential rise in time-motion research pertaining to soccer and this has ultimately improved our understanding of the match demands. Studies demonstrate that players regularly transition between brief bouts of high-intensity running and longer periods of low-intensity running.<sup>1,2,3</sup> In addition to these activities, players frequently perform movements such as tackling, jumping and directional changes integrated alongside technical skills. There may be a tendency amongst practitioners to underestimate the game demands as metabolically taxing activities such as accelerations and decelerations are often omitted from these studies. As with any evidence-based framework in sports performance, detailed knowledge of the physical demands of match play is essential for the design and implementation of specific fitness training.<sup>4</sup> Although time-motion findings have developed our understanding of the physicality of soccer, it's too simplistic to investigate the physical factors in isolation. Rather, it would be advantageous to analyse the contextual interplay between physical, psychological, technical and tactical factors. Moreover, match running performance is highly dependent on many factors that are not often quantified within the research area including match importance, score line, location, opposition standard, recovery days, tactical system, etc. Research typically uses a reductionist approach whereby match-running performance is examined in detail without any integration of these factors and this ultimately leads to a one-dimensional insight into match performance.<sup>5</sup> Accordingly, some authors<sup>6</sup> advocate a more pragmatic approach when interpreting match running performances due to the difficulty in objectively relating it to match-related fatigue, position-specific requirements, subsequent training prescriptions and ultimately competitive success. Contemporary time motion analysis of soccer still only offers a basic snapshot and it's imperative that future research should attempt to integrate multiple approaches to unravel the complexity of the game and its performance determinants. One research criticism is the focus on establishing causal relationships between isolated performance variables (distances, speeds, passes) in an attempt to predict outcomes.<sup>7</sup> This offers an analysis that is pre-occupied with cataloguing and grouping discrete performance behaviors and fitness indices, with little appreciation of the performance context in which functional actions emerge.<sup>7</sup> Indeed, the emphasis on categorizing performance statistics may, unfortunately, lead sports scientists to focus on outcome behavior and not necessarily the motive or cause.<sup>5</sup> This may culminate in somewhat of a reductionist approach that subsequently alters our interpretation of the data.

## Fatigue

The physical demands of competitive match play may result in players experiencing some fatigue and this is construed by game induced decrements in sprinting and jumping test performances at half time and after matches.<sup>8,9</sup> Research demonstrates that running performance declines from the first to the second half of an elite match<sup>10,9</sup> or temporarily after the most intense periods<sup>4,11,12,13</sup>. The reduced distance travelled in the second half could be attributed to fatigue as studies have reported depleted muscle glycogen stores at the end of a match<sup>11,13</sup> with temporary declines after intense periods of match play possibly related to intramuscular acidosis or the accumulation of potassium in the muscle interstitium.<sup>14</sup> The reductions in match running performance may be exacerbated when competing in the challenging environmental conditions, such as the heat. Besides decrements in running performance, Mohr and colleagues<sup>15</sup> reported an average decrease of ~9% for repeated jump performance and nearly a 3% decline in sprint performance. However, given that soccer is a submaximal sport with players likely to be working within their physical capacity it is very difficult to objectively identify fatigue using time-motion analysis. Thus, basing fatigue purely on match running performances is far too simplistic; particularly given that our understanding of physiological responses during elite matches is limited. For instance, it is unknown as to what extent the dynamic responses to match demands prevent total breakdown of any single peripheral physiological system, prematurely or in the final periods of the match.<sup>14</sup> Thus, it would be

erroneous to derive reductions in match running performances across selected periods as fatigue. It may simply represent a statistical artifact, rather than any physiological impairment.<sup>16</sup>

Soccer not only taxes the aerobic and anaerobic energy systems but also taxes players mentally. Once again research typically uses a reductionist approach examining primarily physical fatigue with limited consideration to mental decrements, despite soccer being primarily a skill based sport. The importance of sustained concentration, perceptual ability and decision-making during a match makes this one-dimensional approach somewhat surprising. Although disparity may exist, mental fatigue has been defined as a psychobiological state caused by prolonged periods of demanding cognitive activity, and is characterized by subjective feelings of tiredness, impaired attention and decision-making.<sup>17,18</sup> Whilst the decline in match running performance is often attributed to a player's physical capacity, it is possible that mental fatigue interacts with processes that limit physical ability. A constraint of the player's capacity and/or drive impulse to perform high-intensity actions may manifest during a game<sup>18</sup>. For instance, Smith et al.<sup>19</sup> recently examined the effect of experimentally induced mental fatigue on performance during a 45-min self-paced, intermittent, team sports simulation test. The objective was to identify potential physiological and psychological mechanisms underpinning any change in performance. The findings demonstrated that mental fatigue increases the perception of effort and reduces overall and low intensity running during intermittent running.

Mental fatigue has been hypothesized as an effort/reward imbalance: one will continue working as long as the invested effort results in sufficient rewards.<sup>20</sup> This itself is likely a multi-faceted paradigm whereby as the action of a game unfolds, expectations integrate with contextual factors (e.g. score or time in a match), phase of play (e.g. team in possession) as well as the athlete (e.g. age, fitness and skill level) opponent (e.g. position) and environmental characteristics (e.g. temperature) to provide a confirmation or modification of the anticipated response.<sup>21</sup> However, when the perceived effort becomes too great, and the reward no longer compares to this, the motivation to continue will dissipate. This will possibly result in reduced task involvement.<sup>20</sup> Alternatively, when the given situation is unbalanced and uncontrollable, individuals may need to override signals of the imminent fatigue.<sup>22</sup> The ability to override this signal could be adaptive, as may be the case in uncompromising situations where the importance of the emergency outweighs the possible costs.<sup>23</sup> For example, when a player is under constant pressure from an opponent for an extended period of time. Thus, the decline in match running performance, could be derived from mental, rather than physical fatigue conducive of an effort/reward imbalance.

### **Pacing Strategies**

Some suggest that reductions in match running performance could be due to players employing conscious or subconscious pacing strategies to enable physical and technical performance to be well maintained throughout the latter stages of the match.<sup>24, 25</sup> The overarching notion being within the context of their designated positional responsibilities in a team, players decide when and how to respond to the diverse challenges posed in a game.<sup>26</sup> Observations demonstrate that players will seldom cease participating in a match prematurely due to exhaustion. This is likely moderated by the player and influenced by a number of factors including experience, environment and an array of contextual factors (scoreline, etc). Hence, a drop in the distance covered, whilst often interpreted as a manifestation of fatigue can just as easily be viewed as a player preserving their physical readiness for when the game demands increase.<sup>8</sup> Practically this may seem the case when the outcome has already been decided and another match will follow in a few days, as is the case during a congested fixture. Supposedly, various pacing profiles exist that characterize match-running performance among players. Whole-match players supposedly adopt a 'slow-positive' pacing profile, characterised by a gradual decline in total and high-intensity running<sup>26</sup>. In contrast, part-match players are considered to select either 'all-out' or 'reserve' strategies, depending on their role

189 in the match.<sup>26</sup> Although this ‘all out’ end spurt may not always be a common event.<sup>5</sup> The coaches’  
190 instructions may also be a mediating factor for the part match, but also whole match players.  
191 Indirect evidence of this can be somewhat extrapolated by research showing coaches instructions to  
192 affect the physical demands of soccer activity.<sup>27</sup>

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### 194 **Contextual and Tactical Factors**

195 Research examining contextual factors such as match status (win/draw/lose) and location  
196 (home/away), level of opposition (top, middle and bottom) and match half demonstrates these have  
197 an impact on the running and technical profiles of players.<sup>28,29,30,31</sup> For instance, Castellano et al.<sup>30</sup>  
198 found that the distance covered when the ball was in play (effective playing time distance) in  
199 various movement categories was greater when playing at home vs away and when the opposition  
200 team was losing and of a higher tactical standard. Regarding tactical standard, players of less  
201 successful teams from the English Premier League cover greater distances in high-intensity than  
202 their more successful counterparts.<sup>10</sup> Players of the most successful teams from Italian Serie A,  
203 however, perform more high-intensity activities during a game when in possession of the ball  
204 compared with players of less successful teams.<sup>31</sup> In England it also seems the high intensity  
205 distance covered is greater when moving down from the Premier League to the Championship but  
206 not when players moved up.<sup>32</sup> Finally, when compared to international teams, it seems domestic  
207 players cover a similar high intensity distance in males<sup>2</sup> but less for females.<sup>33</sup> However,  
208 categorization of “successful” and “unsuccessful” and/or “strong” or “weak” opposition tends to be  
209 according to their standings within a tournament or end-of-season classification.<sup>27</sup> Both may lack  
210 the sensitivity and stability to differentiate changes in behaviour incidence as a function of the  
211 quality of the opposition.<sup>27</sup> Hereby a team can lose even after a very good performance (i.e. high  
212 numbers of good goal-scoring opportunities, shots, corners, etc.) or win after a poor performance.

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214 Other contextual factors such as score line seem to be important for dictating physical performance.  
215 Bradley and Noakes<sup>5</sup> observed that elite players covered similar high-intensity running distances in  
216 matches with differing score lines but position-specific trends indicated central defenders covered  
217 17% less and attackers 15% more high-intensity running during matches that were heavily won  
218 versus lost. Tactical factors such as the playing formation also seem to be an influential factor on  
219 the physical performance of elite players.<sup>34</sup> For instance, no differences were found for the overall  
220 running performance of players playing in 4-4-2, 4-3-3 and 4-5-1 but high-intensity running with  
221 ball possession in offensive and orthodox formations were ~30-40% higher than defensive  
222 formations (4-3-3 and 4-4-2 vs 4-5-1). In contrast, ~20% more distance was covered at high-  
223 intensity without possession in defensive versus offensive and orthodox formations. This coincided  
224 with the lowest ball possession for the defensive formation compared to the offensive and orthodox  
225 formations (44 vs 50%), thus ball possession could have been a factor. The multifactorial nature of  
226 soccer denotes that inconsistencies will remain when examining the impact of contextual/tactical  
227 factors have on workload. Indeed, whilst research has examined the effects of contextual factors on  
228 match running performance, only recently has the contextual variability been elucidated<sup>35</sup>. In the study,  
229 researchers examined the factors influencing physical and technical variability in the English Premier  
230 League. Match performance data were collected from multiple seasons (2005-06 to 2012-13) and  
231 consisted of 451 individual players across 3016 observations. The authors concluded that 1) technical  
232 parameters varied more from match-to-match than physical parameters 2) variation is position  
233 dependent and 3) physical and technical performance are variable regardless of context.

234 It seems likely that no single study can comprehensively measure and control for all extraneous  
235 influences. This should not deter researchers, however, from exploring this area with the possibility  
236 of at least establishing a hierarchy with regards to these factors. To gain a better understanding it  
237 would appear that more robust research design are necessary. That being, studies of large samples  
238 as well as, for example, mixed model analysis using multivariate statistical analyses. This review  
239 clearly indicates the complexity of match play and that sports scientists and coaches need to

240 consider various contextual and technical factors before making inferences on time-motion data  
241 supplied by match analysis companies.

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## 244 **Conclusion**

245 The match running performance of elite soccer players has been extensively studied over the last  
246 two decades. It seems that this is impacted by a multitude of factors encompassing fatigue  
247 (physical and mental), pacing, contextual, tactical and quite probably, several other factors.  
248 Physical fatigue, contextual and tactical factors in particular have gained the most attention whilst  
249 other areas are underdeveloped. Collectively, it seems our knowledge has advanced and our  
250 understanding developed in accordance. However, results from time motion analysis can often be  
251 misconstrued, particularly when viewed in isolation. For example, understanding how the  
252 individual interacts with the actual environment is unknown and a likely important factor.  
253 Practitioners are advised to carefully consider the implications of research studies for the field  
254 setting whilst our understanding and knowledge continues to develop and researchers should  
255 endeavor to provide more inter-disciplined understanding of the factors impacting match-running  
256 performance.

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